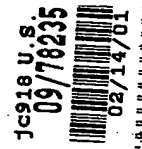




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Attestation

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The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. Patent application No. Demande de brevet n°

00301166.5

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PRIORITY DOCUMENT**

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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Blatt 2 der Bescheinigung
Sheet 2 of the certificate
Page 2 de l'attestation

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Application no.:
Demande n°: 00301166.5

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Applicant(s):
Demandeur(s):
LUCENT TECHNOLOGIES INC.
Murray Hill, New Jersey 07974-0636
UNITED STATES OF AMERICA

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Mobile radio telecommunication system with improved uplink resource allocation

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MOBILE RADIO TELECOMMUNICATION SYSTEM WITH IMPROVED UPLINK RESOURCE ALLOCATION

This invention relates to a mobile radio telecommunication system; in such a system, the method used to allocate resources in the uplink, i.e. in the links to the mobile users, determines the number of channels which can be simultaneously active in
10 any telecommunications cell. Limits are set which may be conservative so as to maintain the stability of the system, and also to ensure that the service provided stays below the maximum outage level allowed in the network.

In a system operated by Code Division Multiple Access (CDMA) in which traffic is homogeneous, e.g. it is all voice traffic, and there is a fixed number of
15 channels, the number of simultaneous links in any telecommunications cell or telecommunications section can be hard limited, i.e. a definite number can be set.

In a system such as the Universal Mobile Telephone System (UMTS), which is a heterogeneous system, i.e. the traffic is of a mixed nature, and there is no fixed number of channels, hard limiting the number of communications links would lead to a
20 very unstable performance. Also, it would be necessary to change the hard limit and to decrease the number of links, as the individual data rate of traffic increased, i.e. as there was less spreading gain.

In a wideband system the cell loading is often measured as the "interference above noise floor". That is, any active mobile user will be generating some amount of
25 interference in the network and hence increasing the loading in the network. The noise floor is the interference level when there are no active users in the system.

It is an object of the invention to provide an improved method of resource allocation suitable for application to a heterogeneous telecommunications system.

According to the invention, in a wideband mobile radio telecommunication
30 system having heterogeneous services with different rates, a method of resource allocation characterized by the steps of determining the current proportions of each rate traffic in a telecommunications cell; and applying a threshold to the loading level in said cell in accordance with said determined proportion.

Also according to the invention, a wideband mobile radio telecommunications
35 system comprising a core network, a plurality of radio network controllers each

controlling a plurality of base transceiver stations, characterized in that each base transceiver station is arranged to determine intermittently the proportions of each rate traffic in a cell controlled by said base transceiver station; and each base transceiver station is arranged to apply a variable threshold to the loading level in each cell.

5 The invention will be described with reference to the accompanying drawings in which:-

Figure 1 is a schematic diagram of a UMTS system;

Figure 2 indicates temporal loading variations in a telecommunication cells; and

Figure 3 is a graph of cumulative distribution functions of the instantaneous
10 loading with different proportions of high data rate services.

In the Universal Mobile Telephone System illustrated in Figure 1, a Core Network (CN)10 has an interface 12 with a plurality of Radio Network Controllers (RNC) 14, 16, each controlling a plurality of Base Transceiver Stations (BTS) 18, 20, 22, 24. For simplicity only two RNCs each controlling two BTSs are shown. The
15 BTSs interface through a radio interface 28 with a number of mobile users 30, 32.

Each BTS 18, 20, 22, 24 is arranged to monitor the loading in the telecommunications cell it controls. Referring now to Figure 2, in each cell there is a noise floor F, present when no users are active, and each BTS measures the interference level above this floor, which is proportional to the load in its cell. The measurement is
20 based on the Received Signal Strength Indicator RSSI which gives a measure of the total interference in a cell. Each BTS has a current load limit and if this limit is reached, the next request for resource, i.e. for a new connection to a mobile, is refused by the BTS.

If the traffic in the cell is voice, the actual loading varies relatively little in the
25 short term, as indicated in Figure 2 by the line V. It is therefore possible to set a fixed limit L which will rarely be exceeded by voice traffic. Since the loading variations in the pure voice case are minimal, this threshold translates to a fixed number of maximum allowed trunks, hence users.

If however the traffic is a mixture of voice and data, as shown by the line M
30 there may be substantial periods when actual instantaneous loading would exceed the fixed loading threshold limit as well as periods during which traffic is well below the

fixed limit. This is due to the bursty nature of high rate users as well as the low spreading gain associated with high rate channels. During the periods of increased loading above line L, (the threshold), some users will be blocked or dropped in the middle of their calls, making the probability of blocking higher as the time spent above the line L is longer. This means that a lower loading threshold L' must be set in such a way that the system will operate below the required loading level L. Thus when the system is carrying homogeneous traffic it will operate at a lower loading level, making the system less efficient. Line F indicates the noise floor.

In the inventive method and apparatus, a dynamic limit is set which varies in accordance with the proportion of high rate terminals which are active in a particular telecommunications cell.

Figure 3 is a plot of the modelled Cumulative Distribution Functions (CDF) of loading in a cell with different fractions of high and low data rate services.

The dynamic traffic was modelled using a Poisson arrival rate and inverse exponential holding time using the Inverse Transfer Method. The CDF for the Poissonious and inverse exponential distributions was used to find the number of arrivals and the values for initial holding times. The results presented here over a period of 10,000 seconds with 1 second sampling time.

Two types of service were simulated, 8kbps voice with 0.5 activity and 144kbps data with 1.0 activity. Four different mixes were modeled and the four plots show the CDFs for no high data rate service and for 10%, 20% and 30% high data rate services. A value of 10 dB loading threshold (interference level above the noise floor) was used in the model.

Figure 3 shows that for pure voice traffic, shown by the chain-dotted line, the instantaneous loading rarely exceeds the 10dB threshold. For 10% high data rate and 90% voice, shown by the dotted line, there is some loading which exceeds the threshold, while for 20% high data rate (broken line) and 30% high data rate (full line) the threshold is highly likely to be exceeded.

The loading values have a wide distribution; if a requirement is set that the system should be loaded below 10dB for a certain percentage of time, another threshold higher than 10dB should be set.

For example, suppose a threshold must be loaded below 10dB 99.9% of the time, for the 10% high data rate loading; the threshold then needs to be decreased from 10dB to $10 - 0.9 = 9.1$ dB.

By extensive simulation, it is possible to find the back-off values for all possible
5 mixes of traffic.

Instead of simply setting a fixed threshold which is appropriate for a situation in which many high data rate terminals are active, it is now proposed that a dynamic threshold is set, depending on the actual mixture of active terminals in a cell. This information is already available for each cell in each BTS 18, 20, 22, 24 via the
10 measurements of RSSI (Received Signal Strength Indicator), but is currently not used in the way now proposed.

Thresholds can be selected so that, for the traffic mix currently applicable, traffic is below the threshold for a selected proportion of the time. A stable system can then be provided when there is a higher proportion of high data rate users, while
15 allowing a greater number of connections during periods when fewer high data rate users are active.

An appropriate position for the setting of a dynamic loading threshold is within each RNC 14, 16. A mobile in a cell controlled by a BTS consumes some of the loading in its serving cell as well as in neighboring cells, so for effective control, a set of
20 BTSs should be controlled, and allocated thresholds, by the controlling RNC. A cell currently experiencing a loading peak can then be allocated appropriate resource, but is also returned to a more stable condition as soon as the loading peak is reduced.

In such an arrangement, each BTS 18, 20, 22, 24 will send intermittently to its controlling RNC 14, 16 a signal indicating the proportions of high and low data rate
25 users currently active within a cell controlled by that BTS.. The RNC 14, 16 can then intermittently allocate to the BTSs it controls an appropriate loading threshold, taking into account the traffic in cells controlled by adjacent BTSs. The periods between the intermittent signaling and allocating is selected to be appropriate to the network. The RNC can maintain a table of threshold values for specific mixes of services, such as
30 those illustrated in Fig. 3, and can select a threshold for a cell to maintain optimum network operation.

CLAIMS

1 In a wideband mobile radio telecommunications system having heterogeneous services with different rates, a method of resource allocation characterized by the steps of determining the current proportions of each rate traffic in
5 a telecommunications cell; and applying a threshold to the loading level in said cell in accordance with said determined proportions.

2 A method according to Claim 1 in which the proportion of high rate users is determined from a received signal strength indication for said cell.

3 A method according to Claim 1 or Claim 2 in which the determining step
10 is performed in a base transceiver station which controls said cell.

4 A method according to Claim 3 in which said base transceiver station sends to a central radio network controller said determined current proportions.

5 A method according to any preceding Claim in which said applied threshold is variable.

15 6 A method according to Claim 5 in which said variable threshold is allocated to each cell by said radio network controller.

7 A method according to Claim 6 in which said radio network controller maintains a table of threshold values for specific mixes of services and selects a threshold for a cell so as to maintain optimum network operation

20 8 A wideband mobile radio telecommunications system comprising a core network (10), and a plurality of radio network controllers (14, 16) each controlling a plurality of base transceiver stations (18, 20, 22, 24); characterized in that each base transceiver station is arranged to determine intermittently the proportions of each rate traffic in a cell controlled by said base transceiver station; and each base transceiver
25 station is arranged to apply a variable threshold to the loading level in said cell.

9 A system according to Claim 8 in which each base transceiver station (18, 20, 22, 24) is arranged to send to the radio network controller (14, 16) which controls it, a signal indicating said proportions and to receive from said radio network controller a variable loading limit to be applied.

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ABSTRACT

**MOBILE RADIO TELECOMMUNICATION SYSTEM
WITH IMPROVED UPLINK RESOURCE ALLOCATION**

5 In a heterogeneous mobile telecommunication system such as the Universal Mobile Telephone system, a method of resource allocation characterized by the steps of determining the current proportion of each rate traffic for a telecommunication cell; the base transceiver station controlling the cell then applying a predetermined threshold to the loading level in that cell.

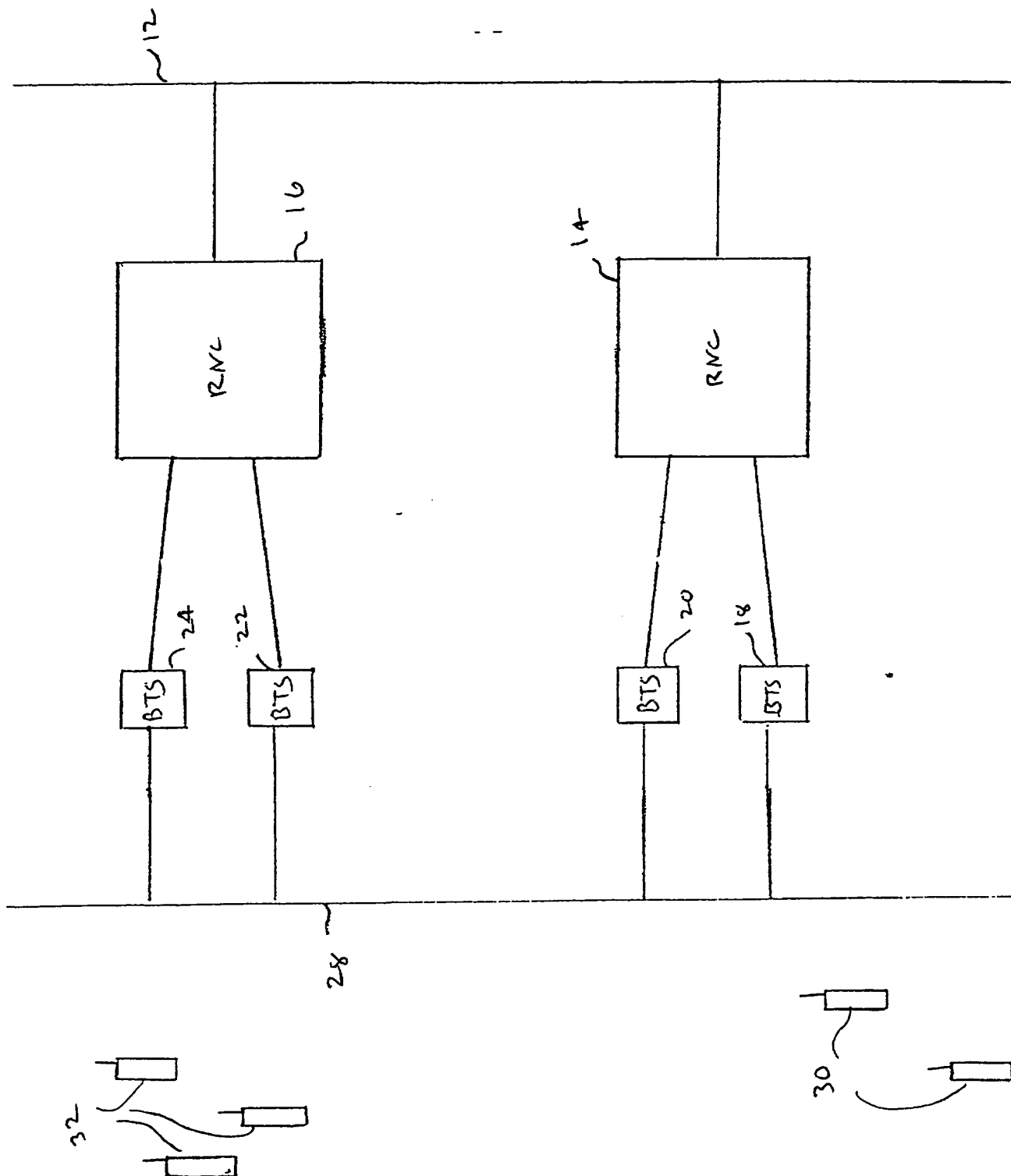
10

Figure 3

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CN 10

FIG. 1



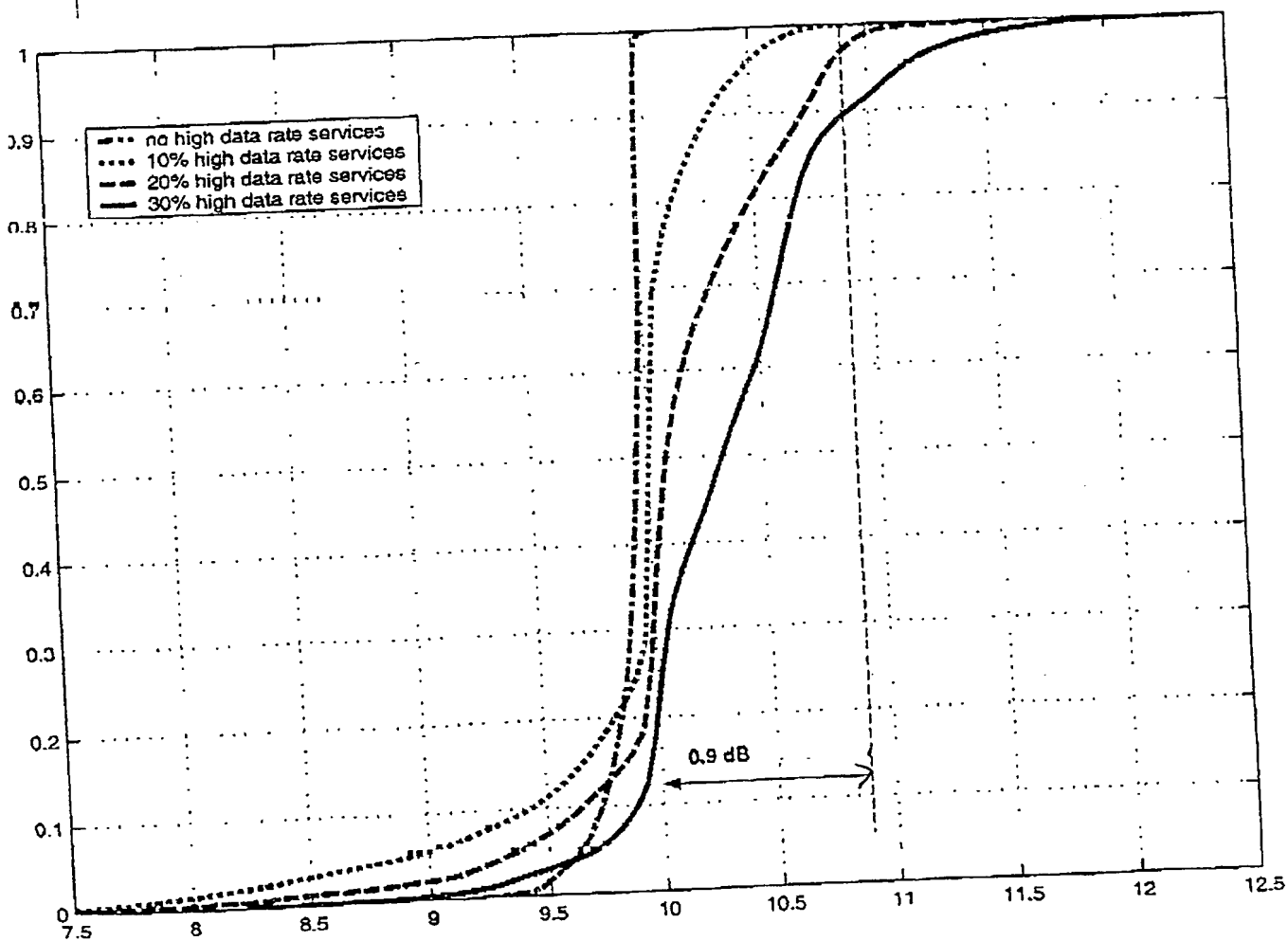
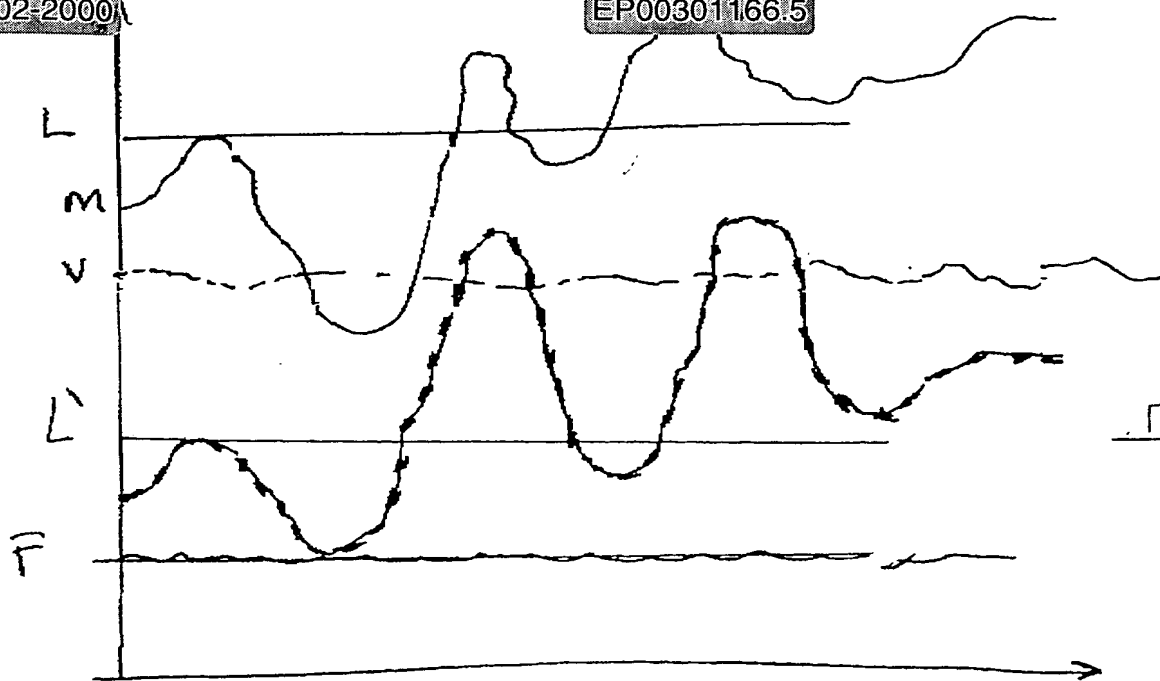


FIG-3